



Race and genetics form their own double helix, twisting together through history. The Nazis, as everyone knows, justified the death camps on the grounds that Jews and Gypsies were genetically inferior—but what is less known is that the Nazis took their cue from eugenics legislation passed in the United States. Here, race is defined primarily by skin color. Since that's a genetic trait, the logic goes, race itself must be genetic, and there must be differences that are more than skin deep.

But that's not what modern genetics reveals. Quite the contrary, it shows that race is truly skin deep. Indeed, genetics undermines the whole concept that humanity is composed of "races"—pure and static groups that are significantly

**What DNA
Says About
Human Ancestry—
and Bigotry**

BY MARK SCHOOF
Photograph by Kevin Irby

THE MYTH OF RACE

different from one another. Genetics has proven otherwise by tracing human ancestry, as it is inscribed on DNA.

Demystifying race may be the most important accomplishment of this research, but it has also solved some of the most intriguing mysteries of human history.

In 1918 a wounded woman showed up in a Berlin mental hospital claiming to be Anastasia, the last surviving member of the Russian imperial Romanoff family. Her story, from which she never wavered, engendered an epic controversy that ranged from courtrooms to the silver screen. The mysterious woman married an American, took the name Anna Anderson, and died in 1984, insisting to her grave that she was the true Anastasia.

After her death, an amateur historian bought some of Anderson's books. →

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SCHOOLS

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In one was an envelope with some strands of her hair. He took them to Mark Stoneking, a Penn State University genetic anthropologist who would later confirm the identity of Jesse James's remains. Meanwhile an English geneticist had obtained some of Anderson's colon tissue that a hospital had stored after an operation. Both researchers analyzed the DNA. "We found that our sequences matched each other," Stoneking recalls, "but they didn't match the royal family."

So who was Anna Anderson? "One of the private investigators hired by other Russian nobility came to the conclusion that she was a Polish woman who had been working in a munitions factory," Stoneking says. There had been an explosion at this factory, which could explain the wounds that gave such credence to her tale of fleeing the Bolsheviks. The English team tracked down a relative of this Polish woman, and, indeed, her DNA matched Anna Anderson's.

If the Polish relative had come from the paternal side of Anderson's family, the English team would have been at a dead end. That's because they were analyzing something called mitochondrial DNA. Almost all human cells contain tiny bacteria-like entities called mitochondria. They provide energy to cells, and they have their own DNA, separate from the DNA that actually makes a person. Mitochondria are not in sperm cells; therefore, they are inherited only from the mother. They record a person's matrilineal heritage.

The paternal counterpart is the Y chromosome. Women, of course, lack the Y chromosome, so it is inherited strictly from father to son. It can be quite revealing to trace how the Y chromosome and mitochondrial DNA mix in a single population. Under the old South African apartheid categories, "colored" people were those who descended from black and white parents—but their Y chromosome almost always shows a European ancestry, whereas their mitochondrial DNA usually shows an African heritage. To put it plainly, white men were sleeping with black women, but black men were not sleeping with white women.

This pattern is common wherever one finds "dominant and subservient groups," says South African researcher Himla Soodyall. In southern Colorado, for example, a group of Hispanics trace their ancestry to Spanish settlers from the 1500s, before Jamestown. "Their oral history says they didn't mix with the native Americans," says University of Michigan researcher Andrew Merriwether, who studied this group. But genetics tells a different tale: about 85 per cent of them carry mitochondrial DNA of Native American origin. Other genetic markers show a strong European heritage, which indicates "directional mating," says Merriwether. As in South Africa, European men were sleeping with Amerindian women, but Amerindian men were rarely sleeping with European women. Partly this is because few Spanish women traveled with the conquistadores, but it's also due to sexual politics, and they are inscribed on DNA.

So are ancient human migrations. Thor Heyerdahl believed that Polynesians crossed the Pacific and helped populate the New World. By sailing his boat, the *Kon Tiki*, he proved such a voyage was possible—but DNA demonstrates that it didn't happen. Polynesians bear a distinctive motif on their mitochondrial DNA that is not present among any native American peoples, either those who are living now or mummies. So did the first Americans come from Siberia? Surprisingly, no. Mitochondrial DNA indicates that native Americans descend from Mongolians.

Such genetic history depends on statistics. Researchers test hundreds or thousands of people in a given population to find what motifs are present and in what concentrations. Then they look for other populations that possess the

same markers. "We try to construct the most likely historical scenario," explains Stoneking, "but we can't rule out more complicated alternatives." He says scientists must triangulate "the fossil, archaeological, and genetic evidence."

But sometimes only DNA can settle questions of human history. Europeans almost all descend from farmers who slowly moved northeast from what is now Turkey. They subsumed the hunter-gatherers whom they encountered, but pockets of the old hunters still remain. The Saami people—formerly known as the Lapps—live in Scandinavia and speak a language close to Finnish. Finns and Saamis "used to say they had a common history, one that goes back to Romantic myths of coming from the Urals," says University of Munich researcher Svante Pääbo. Genetically, the Saami are indeed distinct from the mass of Europeans. "But the Finns look like everyone else in Europe," says Pääbo. "The Finns borrowed their language from the Saami, probably when they came as farmers. Then they pushed away the Saami by taking more and more land." The Basques also seem to be an outpost of the earlier hunters; their DNA carries different motifs than that of the surrounding Europeans.

Japan was populated by ancient Koreans and, earlier, by a mysterious people called the Jomon, known only by their pottery and other archaeological remains. Where did they come from? To figure that out, geneticist Michael Hammer of the University of Arizona looked at the Y chromosome. Surprisingly, the closest match to the Jomon variant lies in Tibet. How could an isolated mountain tribe thousands of miles from the sea be related to the first Japanese? The Tibetans and the Jomon might descend from a common tribe that lived in central Asia, where the Jomon-Tibetan motif is now found only rarely, superseded, perhaps, by the ceaseless mixing of people. But it might also be that migrants from Tibet crossed Asia and entered Japan on an ice bridge 12,000 to 22,000 years ago.

Even individuals can sometimes trace their heritage. (See box, *Roots, DNA Style*.) Matthew George, a geneticist at Howard University, is analyzing the DNA from bones found in the African Burial Ground in Wall Street's Foley Square. Since lab contamination is always a danger, he says, "we test our own mitochondrial DNA." He recalls that an African American colleague had DNA that was closely related to people in Benin. "She started dancing around saying, 'Oh, I'm from Benin, I'm from Benin.' I said, 'No, you're from Plains, Georgia. But, yes, your mitochondrial DNA comes from Benin.'"

with the promise of genealogy comes the danger of bigotry. Genetic classification could "concretize the racist assumptions already out there in the scientific milieu," warns University of Maryland anthropology and biology professor Fatimah Jackson. "This isn't an idle fear I have."

Others share her uneasiness. Ashkenazi Jews are much more likely than other groups to have a mutation that causes breast and ovarian cancer. *New York* magazine recently called this the "Jewish gene," even though non-Jews can also carry it. In the shadow of the Holocaust, some Jews worry about being stigmatized as genetically inferior.

So do African Americans. "Medical literature is replete with black-white distinctions," says Jackson, and many of them are based on bad science. "You realize they sampled 12 black men in Chicago, who are supposed to stand for all African Americans. Science begins with the collection of the sample and the definition of the group to be studied."

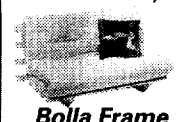
The impact of what Jackson calls "lazy genetics" can be devastating. "With anemia," she recalls, "physicians were being told, 'When you see low hemoglobin levels in a black child, that's not anemia, it's just genetic and you don't

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SCHOOFS

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need to treat. But the same level in a white child needs treatment.' So they disenfranchised all these people by geneticizing what might have been environmental."

Specific problems such as this arise from a general set of assumptions about race. Biology textbooks used to show the ascent of man, leading from apes through Africans and Asians and culminating with Europeans. These racist hierarchies were justified in part by evolutionary theory. Two million years ago, various hominid ancestors of modern humans migrated out of Africa. Neanderthals settled in Europe—and some scientists argued that Europeans descend from Neanderthals, Asians from other hominids such as Peking Man or Java Man, and Africans from still other sources. Genetics has helped demolish this "multiregional" theory.

Mitochondrial DNA indicates that all living humans descend from one maternal source—christened Mitochondrial Eve—who lived in Africa between 100,000 and 200,000 years ago. Similarly, the Y chromosome shows that all men have a common ancestor, Y-chromosome Adam, who lived at the same time. (Actually, both analyses indicate that modern humans descend from a small founding population of about 5000 men and an equal number of women.) The time estimates are based on assumptions on how frequently genetic mutations occur. The mutation clocks of mitochondrial DNA and the Y chromosome tick at different speeds, so the fact that they both indicate humans emerged at the same historical moment makes this evidence much more convincing.

Did modern humans coming out of Africa completely replace Neanderthals and the other earlier hominids—or did they interbreed with them? This year, Stoneking and researchers in Germany compared the mitochondrial DNA of modern humans to that of a Neanderthal skeleton between 30,000 and 100,000 years old. The conclusion: Neanderthals contributed nothing to human maternal ancestry.

But, says Svante Pääbo, who led the Neanderthal project, the question of whether humans mated with other hominids, such as those in Asia, is still open. "The ultimate answer will be to look at 100 or more loci in the genome," he says. "If it all comes from Africa, then that would prove" humans from Africa colonized the globe, replacing their older hominid cousins. But, he says, "I find it hard to believe that there would have been absolutely no interbreeding, that it would be such a simple story."

Indeed, the Y chromosome has begun to tell a more complicated tale. "We found that the

oldest branches in the Y chromosome tree trace to Africa," explains Hammer. "But an intermediate-length branch seems to originate in Asia, and that one led to a newer branch in Africa." In fact, says Hammer, "the majority of the Y chromosomes in Africa seem to be derived from one that may have come from an Asian source." Hammer thinks that after the initial human diaspora out of Africa, there was a reverse migration back into Africa between 10,000 and 50,000 years ago.

This doesn't prove *Homo Sapiens* bred with other hominids: Hammer's Asian Y chromosome could have arisen by mutation, not by interbreeding. But if some breeding with older hominids is proven, might that rekindle the old racist genealogies? Hammer doesn't think so. "Each trait is floating around out there in geographical space," he says. In other words, every person's DNA is a mosaic of segments that originated at various times and in different places.

That helps explain a fundamental finding: Genetic variation within any race is much greater than between races. "If you take even a small camp of Pygmies," says L. Luca Cavalli-Sforza, a pioneer of genetic anthropology, "they are extremely different for all the genetic markers we look at." Indeed, they show almost all the genetic variation catalogued in the world.

racial hierarchies are cultural, not scientific. While every group has genetic characteristics—and sometimes flaws—that are more common than in other groups, not everyone in the group will share them. The Afrikaners, much more than South Africa's other ethnic groups, are prone to porphyria variegata, the blood disorder depicted in the film *The Madness of King George*. It turns the urine purple and can incite temporary insanity. Almost all the South African cases of this disease can be traced to a single Dutch couple who married in Capetown in 1688. Being an Afrikaner is not a risk factor; being a descendant of this couple is.

Not only is race or ethnicity a poor predictor of most genetic traits, it is very hard to define. Many people think they can easily tell an Asian from a European, but, says Pääbo, "If we start walking east from Europe, when do we start saying people are Asian? Or if we walk up the Nile Valley, when do we say people are African? There are no sharp distinctions."

Cavalli-Sforza has probably spent more time trying to classify human groups by genetic analysis than anyone else. In his massive book *The History and Geography of Human Genes*, he groups people into geographic and evolutionary clusters—but, he writes, "At no level can clusters be identified with races." Indeed, "mi-

roots, DNA style

"AT FIRST," CHUCKLES GENETICIST Andrew Merriwether, "I thought you were a chimp." Merriwether analyzed my mitochondrial DNA, which records my mother's line. He found a dozen mutations, six of which are common in chimpanzees. One of these "polymorphisms," as scientists call them, has been found in only two other humans (at least in the databases Merriwether checked). Another hasn't been found in chimps or humans. "Maybe," Merriwether says, "it's a private polymorphism."

It's not uncommon for people to have such unique mutations. So to tell where I come from, Merriwether looked at all my mutations together. My mom has always told me she's 100 per cent Lithuanian, and indeed her lineage is on a branch that includes many Europeans. It's close to Bulgarian Gypsies, who may have originated in India, and it's also close to West African Yorubans and some Asians. Explains Merriwether, "Your DNA fits in a cluster that left Africa and is now dispersed throughout the world."

To find out my ancestry on my dad's side, geneticist Michael Hammer analyzed my Y chromosome: whitebread. Almost three-quarters of British

men have the same type, as well as a third of German and Italian men. Yet the distinguishing motifs on my Y chromosome are occasionally found in India and northern Asia.

Of course, all humans originated in Africa. But once they left there, what were their migration patterns? Here's what scientists now believe:

NATIVE AMERICANS: Originated in central Asia, in what is now Mongolia.

EUROPEANS: Spread northeastward from the area that is now Turkey.

JAPANESE: The first people to settle Japan came from central Asia, or perhaps Tibet; a second migration came from Korea.

MADAGASCANS: Came from mainland Africa—and also from Polynesia.

JEWS: Preliminary evidence suggests that Jews from Eastern Europe to Israel have a Mediterranean origin, and they're closely related to Arabs. But the DNA of Ethiopian Jews seems closer to other Africans than to Mediterraneans.

—M.S.

nor changes in the genes or methods used shift some populations from one cluster to the other."

Geneticist Steve Jones makes this point by looking at blood. "We would have a very different view of human race if we diagnosed it from blood groups, with an unlikely alliance between the Armenians and the Nigerians, who could jointly despise the . . . people of Australia and Peru," who generally lack type-B blood, Jones writes in *The Language of Genes*. "When gene geography is used to look at overall patterns of variation," he writes, "color does not say much about what lies under the skin."

Not only is our concept of race arbitrary, but it is based on a relatively insignificant difference between people. Skin pigment, eye shape, and hair type are all determined by genes. Indeed, as the human genome is mapped, geneticists might be able to recon-

struct what mummies or other ancient people looked like. But the physical "stereotypes" of race, writes Cavalli-Sforza, "reflect superficial differences." For example, light skin color is needed in northern climates for the sun's ultraviolet light to penetrate into the body and transform vitamin D into a usable form. This mutation may well have arisen at different times, in different ancestral groups, on different points along the DNA. That's true for cystic fibrosis, which occurs almost exclusively in people of European descent but is caused by several different mutations.

In other words, "white people" do not share a common genetic heritage; instead, they come from different lineages that migrated from Africa and Asia. Such mixing is true for every race. "All living humans go back to one common ancestor in Africa," explains Pääbo.

"But if you look at any history subsequent to that," then every group is a blend of shallower pedigrees. So, he says, "I might be closer in my DNA to an African than to another European in the street." Genetics, he concludes, "should be the last nail in the coffin for racism."

That's the utopian view. But there are still scientists who claim that inferior genes plague certain races. J. Phillip Rushton, a professor of psychology at Canada's University of Western Ontario, publishes books and articles claiming that "Negroids" have, on average, smaller brains, lower intelligence, more "aggressiveness," and less "sexual restraint" than "Caucasoids" or "Mongoloids."

Rushton's views are on the extreme fringe, but even in mainstream genetics, largely discredited concepts of race persist. Scientific articles constantly speak of "admixture" between

racess, which implies a pure and static standard for each race. "Where did these standards come from?" asks Jackson. "We've taken a 19th-century view of racial variation and plugged in 20th-century technology." Indeed, the whole notion of racial standards—of a pure Caucasian or a pure Negro—is exactly what modern genetics undermines. But, says Jackson, "the philosophy hasn't caught up with the technology."

Over time, "genetics will help beat down racist arguments," says Eric Lander, a world-renowned geneticist at M.I.T. "But they will need to be beaten down, because they will keep coming up."

Part Four: DNA and law enforcement

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